

**NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION**

**MATERIALS AND RESEARCH
DIVISION**

Experimental Study ND 98-01

**Evaluation of Portland Cement Concrete
as a Rehabilitation Option for
Overlaying an Existing Asphalt Roadway**

Second Evaluation Report

Project NH-2-052(012)244

June 2004

Prepared by

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

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U.S. DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION										
EXPERIMENTAL PROJECT REPORT										
EXPERIMENTAL PROJECT	EXPERIMENTAL PROJECT NO.						CONSTRUCTION PROJ NO		LOCATION	
	1	STATE ND	YEAR 1998	-	NUMBER 01	SURF	NH-2-052(012)244 8		Stutsman 28 Counties	
	EVALUATION FUNDING						NEEP NO.	PROPRIETARY FEATURE?		
	48	1	HP&R	3	DEMONSTRATION			Yes		
		2	X CONSTRUCTION	4	IMPLEMENTATION		49	51 X No		
SHORT TITLE	TITLE 52 Evaluation of Portland Cement Concrete as an Option for Overlaying an Existing Asphalt Roadway									
THIS FORM	DATE	MO.	YR.	REPORTING						
	140	05	--	2004	1	INITIAL	2	X ANNUAL	3 FINAL	
KEY WORDS	KEY WORD 1 145 Pavement Concrete				KEY WORD 2 167 Overlays					
	KEY WORD 3 189				KEY WORD 4 211					
	UNIQUE WORD 233 Whitetopping				PROPRIETARY FEATURE NAME 255					
CHRONOLOGY	Date Work Plan Approved		Date Feature Constructed:		Evaluation Scheduled Until:		Evaluation Extended Until:		Date Evaluation Terminated:	
	06-98 277		06-98 281		06-08 285		289		293	
QUANTITY AND COST	QUANTITY OF UNITS (ROUNDED TO WHOLE NUMBERS)			UNITS				UNIT COST (<i>Dollars, Cents</i>)		
				1 LIN. FT 2 SY 3 SY-IN 4 CY	5 TON 6 LBS 7 EACH 8 LUMP SUM					
	297			305				306		
AVAILABLE EVALUATION REPORTS	X CONSTRUCTION			X PERFORMANCE			FINAL			
	315									
EVALUATION	CONSTRUCTION PROBLEMS				PERFORMANCE					
	1	X	NONE		1	EXCELLENT				
	2		SLIGHT		2	GOOD				
	3		MODERATE		3	X	SATISFACTORY			
	4		SIGNIFICANT		4	MARGINAL				
	318	5	SEVERE		319	5	UNSATISFACTORY			
APPLICATION	1	ADOPTED AS PRIMARY STD.			4	PENDING				
	2	PERMITTED ALTERNATIVE			5	REJECTED				
	320	3	ADOPTED CONDITIONALLY			6	NOT CONSTRUCTED			
REMARKS	(Explain in remarks if 3, 4, 5, or 6 is checked)									
	321 The test sections are performing satisfactory. Longitudinal cracking has occurred in two of the test sections that are adjacent to HBP. There is also low severity transverse and longitudinal joint spalling which is typical of PCC pavements.									

Experimental Study ND 98-01

**Evaluation of Portland Cement Concrete
as a Rehabilitation Option for
Overlaying an Existing Asphalt Roadway**

SECOND EVALUATION REPORT

Project NH-2-052(012)244

June 2004

Written by
Curt Dunn and Bryon Fuchs

Disclaimer

The contents of this report reflect the views of the author or authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not reflect the official views of the North Dakota Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

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Evaluation of Portland Cement Concrete as a Rehabilitation Option for Overlaying an Existing Asphalt Roadway

Objective

The objective of this experimental feature is to determine if whitetopping is a feasible option for rehabilitation of an asphalt roadway.

Whitetopping is the process of placing concrete on an existing asphalt roadway. An advantage of whitetopping is the ability to resist rutting and shoving that can cause collection of water on the roadway. Whitetopping impedes structural related distresses such as loss of support, pumping, faulting and corner breaks when constructed on a strong base. Another advantage of this process is to bridge isolated problems that would be reflected through a flexible pavement.

The concept behind whitetopping is that when PCC is bonded to an underlying layer of asphalt, the two form a composite layer forcing the neutral axis in the slab downward. This would cause more of the concrete to be acting in compression rather than tension.

Whitetopping has not been a rehabilitation method used by the North Dakota Department of Transportation in the past.

Scope

In order to determine the effectiveness of whitetopping as possible rehabilitation technique, the North Dakota Department of Transportation (NDDOT) elected to set up a test section to collect and evaluate performance data on this type of project. The NDDOT has constructed three test sections of 5", 6", and 7" of PCC to be placed over an existing asphalt section.

The whitetopping sections were part of a larger project (NH-2-052(012)244) which comprised of mining the existing base and asphalt sections together and applying a new layer of hot bituminous pavement (HBP). This particular roadway was chosen because it had good existing soil conditions and considerable truck traffic.

Each whitetopping test section was approximately 500' in length separated by transition sections of 50'.

Location

The location for this experimental project is north of Jamestown on Highway 52 between Pingree and Buchanan. Refer to Figure 1 for project location. The total project length is approximately 7.743 miles long. The whitetopping test sections and the corresponding control section are between Reference Points 249 and 250.

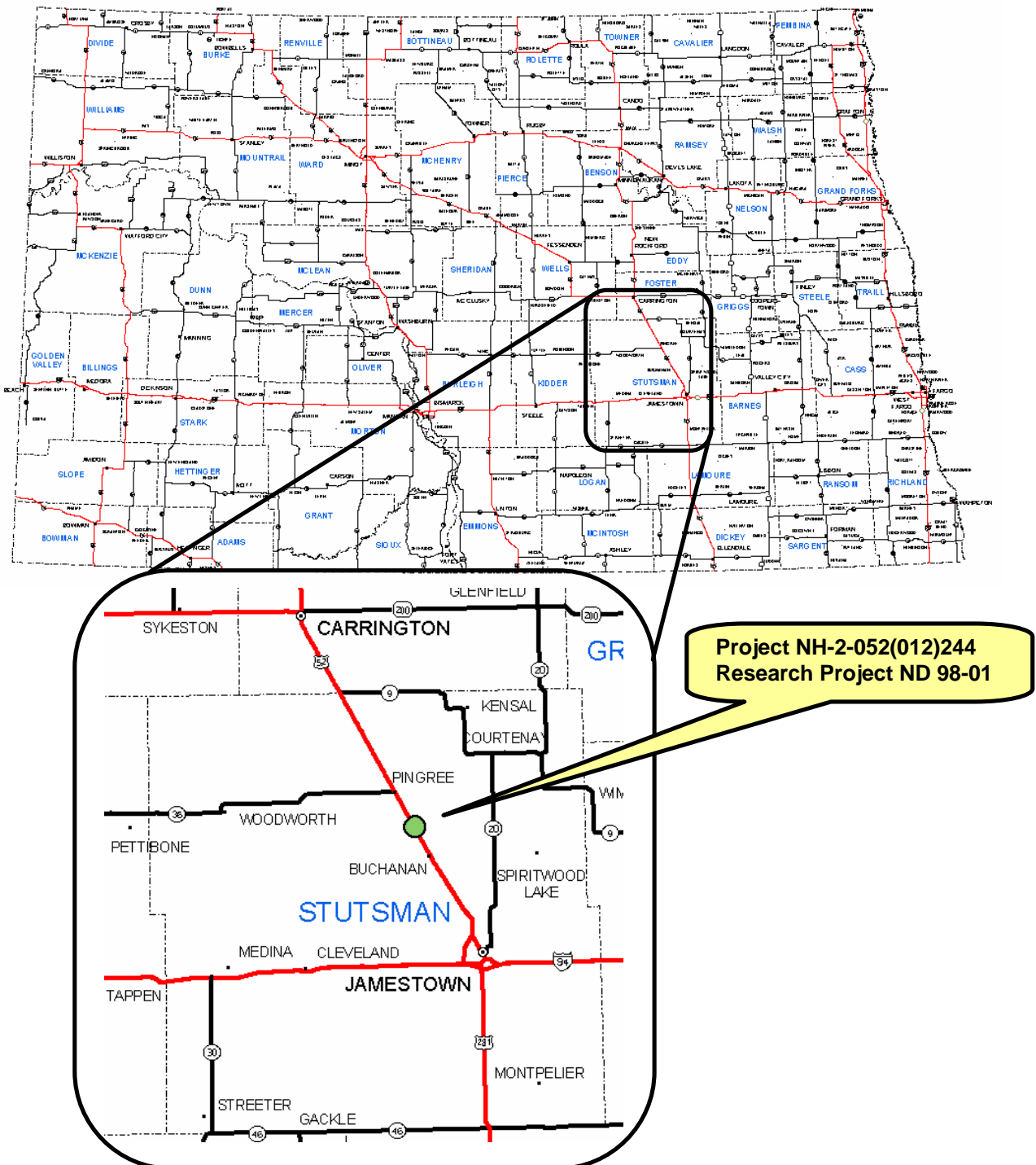


Figure 1 - Project location.

Project Historical Information

Construction

Project history for the roadway section is shown in Table 1.

Junction ND 36 South to 4-lane at Buchanan				
Year	Construction	Depth	Width	Asphalt Oil
1948	Grade	-	36'	-
1950	Aggregate Base	4.0"	32'	-
1950	Hot Bituminous Pavement	4.0"	22'	-
1966	Shoulder Widening	-	48'	-
1966	Bituminous Base Shoulders	-	16'	SM-K
1966	Hot Bituminous Leveling Course	1.5" - 5.3"	24'	SM-K
1966	Hot Bituminous Pavement	1.5"	24'	120-150
1973	Hot Bituminous Pavement	0, 1.1", 1.5"	0, 12', 24'	200-300
1978	Dugouts	1.0' - 1.5'	-	120-150
1978	Aggregate Base Shoulders	4.0"	18'	-
1978	Hot Bit Pavement	2.5"	24'	120-150
1990	Maintenance Chip Seal	-	24'	MC-3000
1995	Hot Bituminous Pavement Patch	1.5"	-	120-150

Table 1

Traffic

Past and current two-way daily traffic is shown in Table 2.

Year	Pass	Trucks	Total	ESAL Annual Growth Rate	Two-way ESALs	
					Flexible	Rigid
1998	1,750	550	2,300	2.0%	480	800
2000	1,920	480	2,400	1.8%	425	700
2004	1,155	500	1,655	1.8%	445	725

Table 2

Design

NDDOT considered several roadways as candidates for a whitetopping test section. US 52 was considered because of its good existing soil conditions, a thick section of existing asphalt (approximately 17"), and considerable truck traffic.

The roadway in question was experiencing distresses such as longitudinal and transverse cracking, rutting (1/8" to 3/8") and shoving pavement, and depressed transverse cracks. This segment of roadway was listed as poor for the ride and the international roughness index. Photo 1 depicts an overview of a segment of US 52 and a close-up of a depressed crack area. One of the rehabilitation options of this roadway was to mill the existing asphalt and overlay with new HBP. However, this option was not considered since the existing cracks would inevitably reflect through the new pavement.



Photo 1 - Overview of distressed areas on a segment of US 52.

The option of mining and blending the existing asphalt and base together and overlaying with HBP was chosen. The proposed asphalt rehabilitation was to mill and remove 9" of asphalt. Aggregate was placed on the remaining roadway structure and blended together to achieve a 14" base. A 5" layer of HBP was placed on the blended base section.

It was also decided that whitetopping test sections be would constructed by milling the existing asphalt and overlaying with PCC. This option was chosen in part to determine if PCC has the ability to control reflective cracking.

The experimental feature was designed to consist of milling 5" to 7" of existing asphalt and then placing PCC of various thicknesses as follows in Table 3.

Test Section	Depth (Inches)
1	5
2	6
3	7

Table 3

The total length of the whitetopping was designed to be approximately 1600 feet. A transitional distance of 50 feet was to be placed in between each section. Figure 2 shows the sections of the experimental feature.

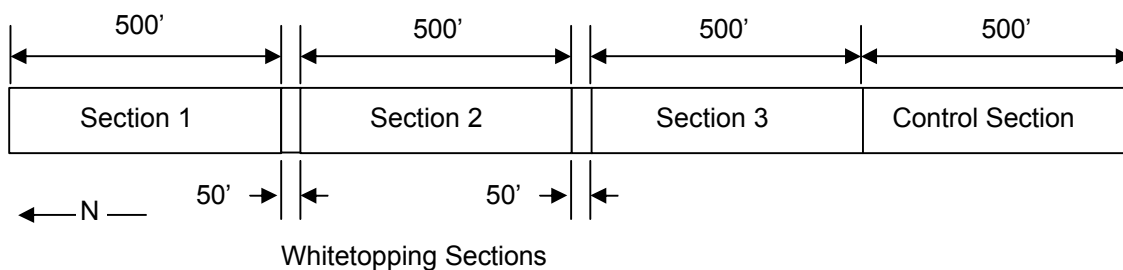


Figure 2 - Experimental sections.

The width of the lanes within the experimental feature were originally designed to be 13.5' with 4.5' asphalt shoulders, however, they were later changed to 12' wide lanes with 6' concrete shoulders. The longitudinal joint tie bar sizes and spacings are listed in Table 4.

Pavement Depth	Location	Bar Size	Bar Spacing
5"	Centerline	#4 x 2' -0"	2' -6"
6"	Centerline	#4 x 2' -0"	2' -10.5"
7"	Centerline	#4 x 2' -0"	3' -3"
5"	12' left and right	#2 x 1' -6"	2' -6"
6"	12' left and right	#2 x 1' -6"	2' -10.5"
7"	12' left and right	#3 x 1' -6"	3' -3"

Table 4

The transverse joint spacing within the experimental feature were originally designed to be 12' for the 5" thick section, 13' for the 6" section, and 14' for the 7" section; however, they were later changed as shown in Table 5. This design approach was more in line with the American Concrete Paving Association (ACPA) practices.

PCC Pavement Depth	Joint Spacing
5"	10.0'
6"	11.5'
7"	13.0'

Table 5

Transverse joint saw cut depths were designed for $T/4 + 1/4"$ with the saw cuts to be $1/8"$ wide.

Surface preparation for the whitetopping sections was to mill the existing asphalt. The milling established the grade-line and crown for the concrete section. After the milling is completed it is very important that the remaining surface be thoroughly cleaned and free of loose particles and dust in order to establish favorable conditions for a proper bond between the existing asphalt and the PCC.

Construction

Whitetopping Section

Construction of the whitetopping test sections began on June 16, 1998. The contractor was Upper Plains Contracting. The contractor began paving at approximately 6:30 a.m. NDDOT project engineer was James O'Brien of the Valley City District. A research team from the NDDOT visited the site.

Photo 2 depicts the surface after the milling was concluded. Upon further examination there appeared to be some loose particles and dust still present on the surface. On the left side of Photo 2 tie bars are visible which are located between the impending shoulder and mainline.



Photo 2 - HBP surface after milling was concluded.

All of the PCC was batched in Jamestown, North Dakota and transported to the site in ready mix trucks.

Photo 3 depicts an overview of the finished slab in the northbound lane of section 1 (5" PCC). The contractor commented that during the construction of the 5" PCC slab he had to lower the tie bars. This was necessary since the paver was hitting the top ends of the bars leaving them sticking out of the slab after the paver passed over them.



Photo 3 - Overview of finished slab in the northbound lane of section 1 (5" PCC).

Photo 4 depicts a view of excess curing compound that was sprayed where the southbound lane would be constructed.

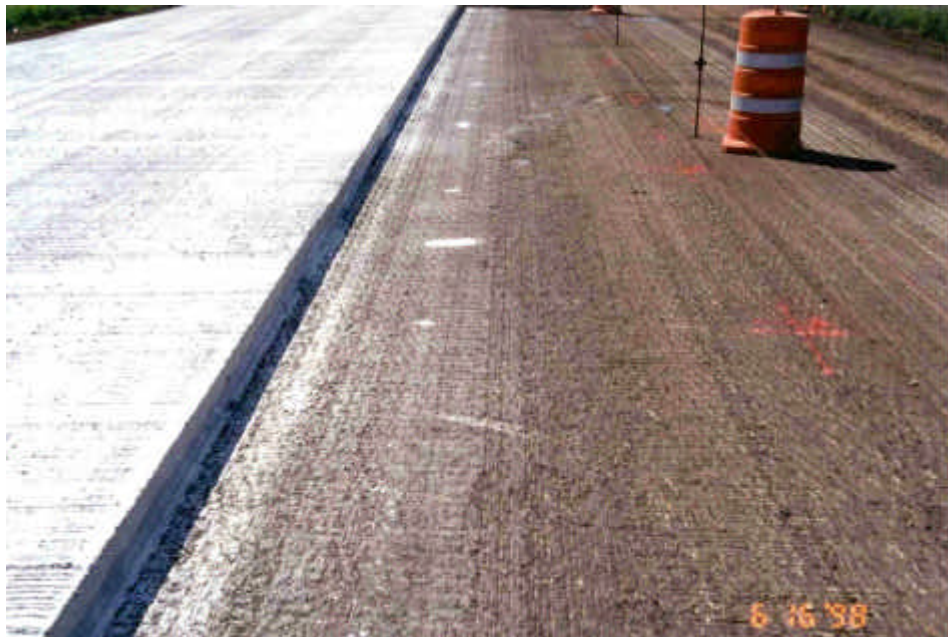


Photo 4 - View of excess curing compound sprayed where the southbound lane would be constructed.

The NDDOT personnel were concerned the over-sprayed curing compound would hamper the bonding effect between the PCC and the existing asphalt. The contractor agreed to remove the compound from the surface prior to placing the slab. The contractor finished all three test sections in the northbound lane by mid to late afternoon. Although precise times were not kept, the placing of the 6" slab required a little more time than the 5" slab because of the increase in the volume of PCC. The contractor commented that the job would have progressed at a faster rate if the ready mix trucks could have kept up to the paver.

On June 25, 1998 the contractor began paving the southbound lane. A research team from the NDDOT again visited the site to monitor and evaluate the construction of the other half of the whitetopping test sections. Photo 5 is an overall view of the paving operation in the southbound lane.



Photo 5 - Paving operation in southbound lane.

Photo 6 shows a close-up view of small particles and dust that remained on the milled surface and were not blown off prior to paving.



Photo 6 - Small particles found on the HBP prior to being blown off.

Photo 7 depicts an overall view of test section 1. A representative of the Materials and Research Division visited the site a few weeks after construction. The test sections were free of distresses except for a longitudinal crack located in the northbound lane near the beginning of test section 1. Photo 8 depicts a view of this distress which spans approximately 40'.



Photo 7 - Overall view of test section 1.



Photo 8 - Longitudinal crack in test section 1 after construction.

Control Section

As previously mentioned the Control Section is composed of a blended base overlaid with HBP. The existing section was first milled to a depth of 9". After the milling operation was completed, 6" of course aggregate was placed on the remaining roadway structure and blended together to achieve a blended 14" base. A 5" layer of HBP consisting of 3" of recycled large stone mix topped with 2" of Class 31 was then placed on the blended base section. The project engineer commented that the construction phase went well.

As previously mentioned the performance of this section will be compared to the white topping test section.

Cost

Table 6 tabulates the following bid items associated with the whitetopping test sections.

Description	Units	Unit Bid
5" Non-Reinforced Concrete Pavement Class AE	SY	\$20.40
6" Non-Reinforced Concrete Pavement Class AE	SY	\$23.25
7" Non-Reinforced Concrete Pavement Class AE	SY	\$25.70
Milling Bituminous Pavement	Ton	\$3.60

Table 6

Table 7 tabulates the following bid items associated with the asphalt control section.

Description	Units	Unit Bid
Milling Bituminous Pavement	Ton	\$3.60
Aggregate Base Course Class 5	Ton	\$4.85
Blended Base Course	SY	\$1.17
Water	M Gal	\$12.00
MC70 or 250 Liquid Asphalt	Gal	\$0.87
Blotter Material Class 44	Ton	\$9.55
SS1H or CSS1H Emulsified Asphalt	Gal	\$0.87
Virgin Aggregate Large Stone Mix	Ton	\$5.50
Recycled Hot Bituminous Pavement-Large Stone Mix	Ton	\$6.70
120-150 Asphalt Cement	Ton	\$137.00
Hot Bituminous Pavement QC/QA Class 31	Ton	\$13.20
Trimming Base Course	SY	\$0.24

Table 7

Table 8 tabulates the price per square yard of the each pavement section. The unit prices listed above was used to tabulate the square yard price. The prices do not reflect items such as contract bonds, flagging, testing, mobilization, etc.

	Blend Base/HBP	5" Whitetopping	6" Whitetopping	7" Whitetopping
Price/SY	\$10.11	\$21.40	\$24.45	\$27.10

Table 8

Evaluation

On September 18, 2003 a two member NDDOT research team traveled to the PCC overlay test section to conduct the first evaluation of this project. This test section is located on highway 52 between RP 249 and 250. The team consisted of Steve Henrichs and Bryon Fuchs of Materials and Research division. All three test sections appeared to be performing well. The following pages will describe the findings of this evaluation.

Test Section 1

The first test section, which is composed of 5" PCC and 12" of HBP base, showed the most signs of distress along the joints of all three test sections. Photo 9 was taken in 2003. It shows a general overview of the first test section.



Photo 9 - Overview of test section 1 looking south.

During a post construction evaluation of section 1, it was discovered that some cracks had begun to form. In the summer of 1999 the Valley City district performed some preventative maintenance on the longitudinal cracks. This process consisted of sawing out $\frac{1}{2}$ " of PCC around the cracks and filling with the polymer sealant CRAFCO 231. Photo 10 taken in 2001 shows one of the repaired cracks.



Photo 10 - Repaired longitudinal crack.

The review team located approximately 140 ft of low severity longitudinal cracking that occurred in Section 1. One corner break was also noticed. Some spalling was occurring at approximately every other transverse joint. The sealant was losing contact with portions of the PCC panels due to spalling. Photo 11 shows the condition of a typical joint and areas of low severity spalling.

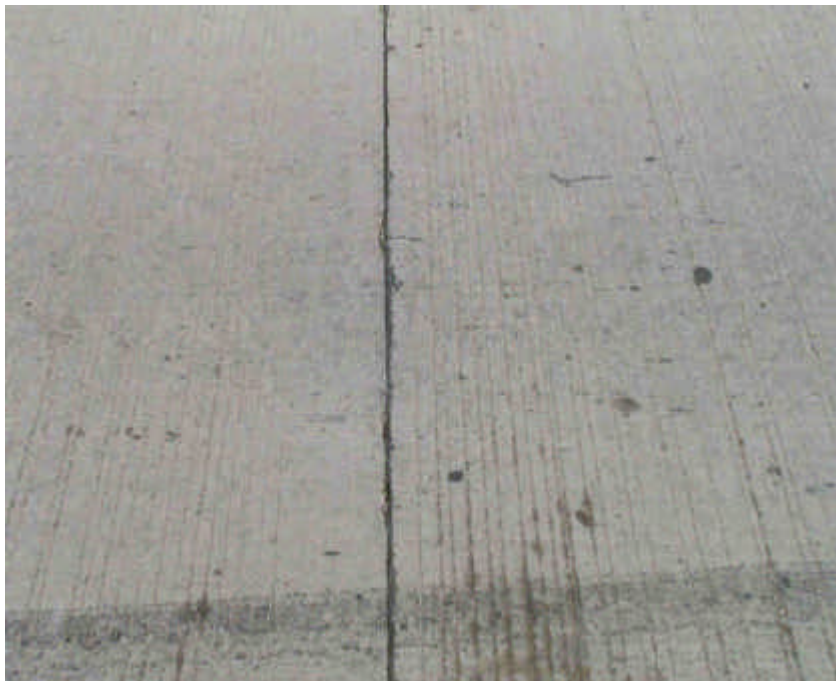


Photo 11 - Typical transverse crack.

The centerline joints also showed signs of distress with low severity spalling and some sealant damage. Photo 12 illustrates one of the more severe distress areas along the centerline joint.



Photo 12 - Longitudinal joint spalling and adhesion failure in the sealant.

Longitudinal and transverse joints along the shoulder are performing well. The shoulders in this section show no signs of distress.

There is one area that is starting to block crack, which indicates a possible subgrade problem.



Photo 13 - Block cracking starting to occur in section 1.

Provided in the following table are the distresses noted in each evaluation.

Section 1			
Evaluation	Longitudinal Cracking	Transverse Cracking	Other distresses
2001	130 feet in NB lane	0 feet observed	Low severity spalling at joints
2003	130 feet in NB lane 10 feet in SB lane	12 feet in SB lane	Low severity spalling at joints 1 corner break Block cracking in one location

Table 9

Test Section 2

The second test section is composed of 6" PCC and 11" of HBP base and the overall pavement condition is performing very well.



Photo 14 - Overview of test section 2 looking south.

Section 2 has some low severity spalling occurring at transverse joints and also the centerline longitudinal joints. There is also approximately 12 feet of longitudinal cracking. Longitudinal and transverse joints along the shoulder are performing very well. The shoulders in this section show no signs of distress.

Provided in the following table are the distresses noted in each evaluation.

Section 2			
Evaluation	Longitudinal Cracking	Transverse Cracking	Other distresses
2001	0 feet observed	0 feet observed	Low severity spalling at joints
2003	0 feet in NB lane 11.5 feet in SB lane	0 feet observed	Low severity spalling at joints

Table 10

Test Section 3

The third test section is composed of 7" PCC and 10" of HBP base and the overall pavement condition is performing satisfactory.



Photo 15 - Overview of test section 3 looking south.

The review team located approximately 104 feet of low severity longitudinal cracking that occurred in Section 3.



Photo 16 - Longitudinal crack adjacent to control section looking north.

There were also four corner breaks in this section which still appeared to be very tight.



Photo 17 - Test section 3 corner break and longitudinal crack.

Section 3 has some low severity spalling occurring at transverse joints and also the centerline longitudinal joint.

Longitudinal and transverse joints along the shoulder are performing very well. The shoulders in this section show no signs of distress.

Provided in the following table are the distresses noted in each evaluation.

Section 3			
Evaluation	Longitudinal Cracking	Transverse Cracking	Other distresses
2001	40 feet in NB lane	0 feet observed	Low severity spalling at joints 1 corner break
2003	91 feet in NB lane 13 feet in SB lane	0 feet observed	Low severity spalling at joints 4 corner break

Table 11

Control Section

The review team also inspected the asphalt control section located directly south of the whitetopping test site. The section appeared to be in good condition. Photo 18 shows the general condition of the control section. Some bleeding had occurred in the north bound lane.



Photo 18 - Overview of control section looking south.

There were also a few isolated patches where the chip seal had been scraped off the HBP near an existing approach. It was believed that this may have been caused by farm machinery or some other form of heavy equipment.

Two transverse cracks were identified within the control section. Minor rutting has occurred, ranging from 1/16" to 1/8".

Provided in the following table are the distresses noted in each evaluation.

Control Section			
Evaluation	Longitudinal Cracking	Transverse Cracking	Other distresses
2001	0 feet observed	2 – entire roadway width	None noted
2003	0 feet observed	2 – entire roadway width	1/16" to 1/8" rutting

Table 12

Ride

During the inspection, the review team drove over both the test and control sections. Both sections seemed to ride well. The transitions between sections were

very smooth, and both the PCC and the asphalt control sections seemed to be in good condition.

Falling Weight Deflectometer (FWD)

FWD data was collected for this test site in 2000, 2001, 2002, and 2003. Refer to Appendix B for graphs.

FWD Data					
Section	Station	2000 Soil Modulus (ksi)	2001 Soil Modulus (ksi)	2002 Soil Modulus (ksi)	2003 Soil Modulus (ksi)
1	249.3226	13.2	11.0	11.6	10.5
	249.3276	12.7	11.2	9.6	13.9
	249.3326	12.1	9.6	9.7	9.6
	249.3376	13.4	7.6	9.3	9.9
	249.3426	11.3	8.0	8.9	10.0
	249.3476	12.7	13.0	9.9	11.7
	249.3526	13.2	12.9	8.5	10.9
	249.3576	13.1	12.8	9.4	11.7
	249.3626	17.5	12.4	10.4	11.3
2	249.3801	15.3	17.7	15.0	21.4
	249.3850	16.8	15.6	18.5	12.9
	249.3901	20.9	19.9	12.6	11.3
	249.3950	14.0	11.7	12.8	18.7
	249.4000	13.8	17.9	17.4	15.6
	249.4050	19.6	11.4	11.4	12.3
	249.4100	15.2	15.2	10.4	13.1
	249.4151	26.5	16.1	15.6	13.2
	249.4200	15.0	25.6	14.3	9.5
3	249.4350	20.9	14.7	12.1	19.3
	249.4400	17.0	25.0	13.1	18.9
	249.4450	16.4	15.3	15.7	15.5
	249.4500	24.6	21.5	19.2	24.4
	249.4550	25.1	19.3	9.4	13.6
	249.4600	17.4	20.3	15.2	15.7
	249.4650	18.5	22.5	19.6	21.5
Control	249.4901	10.1	8.7	N/A	11.5
	249.4950	11.1	9.9	N/A	12.1
	249.5001	13.7	9.1	N/A	14.5
	249.5051	15.6	10.7	N/A	15.0
	249.5101	10.8	12.5	N/A	11.0
	249.5150	17.0	15.3	N/A	20.7
	249.5200	18.8	10.4	N/A	24.5
	249.5253	15.6	15.2	N/A	20.7

Table 13

Summary

Test sections 1 and 3 are showing the most distresses. The primary distress is longitudinal cracking. Test sections 1 and 3 are adjacent to hot bituminous pavement sections. Test section 1 had a 40' longitudinal crack that appeared immediately after construction. Test section 2 is performing well with only minor distresses. The control section is performing well with minor rutting and two transverse cracks.

The longitudinal cracking in test sections 1 and 3 are likely the result of poor subgrade conditions. The location of the longitudinal cracks is in the same area as the distresses shown in photo 1 prior to whitetopping the asphalt. These distresses appeared to have reflected through the whitetopping sections.

The ride remains good in all sections. The distresses have not affected the ride to this point.

Appendix A

DESIGN DATA				
Traffic	Average Daily		Est. Max. Hr.	
Current 1997	Pass: 2017	Trucks 480	Total 2300	230
Forecast 2017	Pass: 2180	Trucks 580	Total 2760	280
Minimum Sight Dist. for:		Design Speed 60 MPH		
Stopping 600'		Bridges		
Safe Passing 2300'				
Passing for Marking 1000'				

JOB# 2

FED. REGION	STATE	PROJECT NO.	SHEET NO.
8	ND	NH-2-052(012)244	1

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

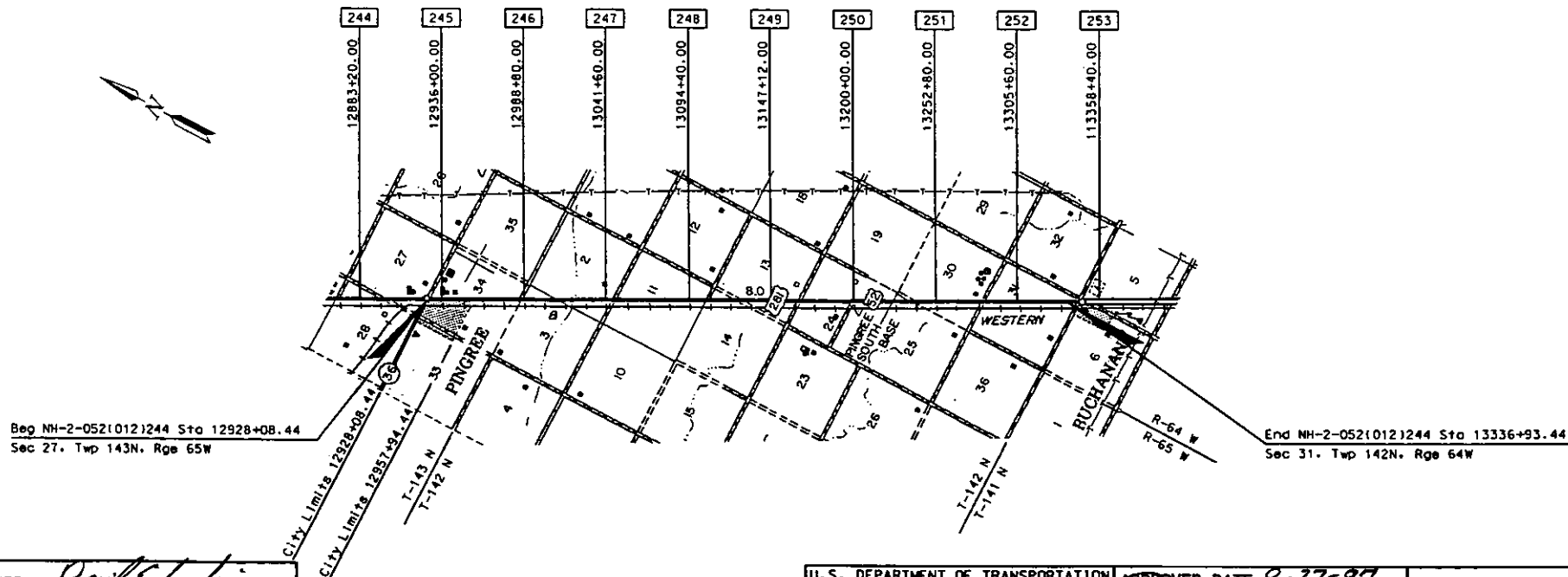
GOVERNING SPECIFICATIONS:

Standard Specifications adopted by the North Dakota Department of Transportation October 1997: Standard Drawings currently in effect; and other Contract Provisions submitted herein.

IN STUTSMAN COUNTY
FEDERAL AID PROJECT NO NH-2-052(012)244
BLENDED BASE COURSE, RECYCLED HOT BITUMINOUS PAVEMENT LARGE STONE MIX.
&
HOT BITUMINOUS PAVEMENT

LENGTH OF PROJECT

7.743 Miles



DESIGNER David E. Jones
DESIGNER _____
DESIGNER _____
RECOMMEND APPROVAL 8-27 1997
DESIGN ENGINEER: K. E. Jones

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

APPROVED

DIVISION ADMINISTRATOR

DATE

APPROVED DATE 8-27-97
David E. Jones
P.E. 1199

DIRECTOR OF HIGHWAYS
AND ENGINEERING

NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION

FHWA REGION	STATE	PROJECT NO.	SHEET NO.
8	ND	NH-2-052(012)244	8

BASIS OF ESTIMATE

<u>DESCRIPTION</u>	<u>UNITS</u>	SECTION ⑥		SECTION ⑨		SECTION ⑩		SECTION ⑪	
		<u>QUANTITY PER MILE</u>	<u>WIDTH</u>	<u>QUANTITY PER MILE</u>	<u>WIDTH</u>	<u>QUANTITY PER MILE</u>	<u>WIDTH</u>	<u>QUANTITY PER MILE</u>	<u>WIDTH</u>
Water for Dust Palliative @ 25 MGal/Mile, for Blended Base @ 15 Gal/SY, & for Borrow @ 10 Gal/CY	MGal	423		25		25		25	
Salvaged Aggregate Base (shoulders)	Ton	1811							
Aggr Base Course Class 5 @ 1.875 Ton/CY	Ton	5767	38'						
Blended Base Course (existing base, existing Aggregate Base shldrs, and class 5)	SY	25227	43'						
MC-70 or 250 Liq Asph for Prime Coat @ 0.18 Gal/SY (top of Blended Base Course)	Gal	4224	40'						
MC-70 or 250 Liq Asph for Prime Coat @ 0.25 Gal/SY (top of reshaped aggr shldrs)	Gal			2053	7'-7'	2053	7'-7'	2053	7'-7'
SS-1h or CSS-1h Emuls Asph for Tack Coat @ 0.05 Gal/SY (top of prime)	Gal	1115	38'	381	6.5'-6.5'	381	6.5'-6.5'	381	6.5'-6.5'
SS-1h or CSS-1h Emuls Asph for Tack Coat @ 0.05 Gal/SY (between shldr lifts & top of large stone mix)	Gal	1056	36'	352	6.5'-6.5'	352	6.5'-6.5'	352	6.5'-6.5'
Blotter Material CI 44 @ 8 Lbs/SY for Prime Coat Maintenance	Ton	89	38'	33	7'-7'	33	7'-7'	33	7'-7'
Recycled Hot Bit Pvmnt - Large Stone Mix @ 2.0 Ton/Cy (70% virgin aggregate, 30% milled bit material)	Ton	3119	36'						
120-150 Asph Cement for Rec Hot Bit Pvmnt - Large Stone Mix @ 3.6% of Rec Hot Bit Pvmnt	Ton	112.18							
Virgin Aggregate for Recycled Hot Bit Pvmnt - Large Stone Mix	Ton	2105							
Hot Bit Pvmnt Class 31 @ 2.0 Ton/CY	Ton	2471	36'	1791	4.5'-4.5'	1936	4.5'-4.5'	2082	4.5'-4.5'
120-150 Asph Cement for CI 31 Hot Bit Pvmnt @ 5.8% of CI 31 Hot Bit Pvmnt	Ton	143.3		103.9		112.3		120.8	
Milling Bituminous Pavement	Ton	7123		4105		4105		4105	

BASIS OF ESTIMATE

- 100 WORK SCHEDULE: In order to minimize interference with traffic
020 operations, a detailed schedule shall be agreed to prior to
beginning work, between the engineer, utility companies, and
the contractor and subcontractors, if any.
- 105 The contractor shall notify the local utility companies prior to
P01 the beginning of construction, so they may determine the location
of all utilities in the project area.
- 110 This project is subject to the conditions of Section 404 Nation-
P01 wide Permit No. 26. The following special conditions, if
applicable, must be met:
1. Heavy equipment working in wetlands must be placed on
mats or other measures must be taken to minimize soil
disturbance.
 2. No discharge of dredge or fill material may consist of
unsuitable material (e.g., trash, debris, car bodies, etc.)
and material discharged must be free from toxic pollutants
in toxic amounts.
 3. Any structure or fill authorized will be properly maintained,
including maintenance to ensure public safety.
 4. Appropriate erosion and siltation controls must be used and
maintained in effective operating condition during construc-
tion, and all exposed soil and other fills must be permanently
stabilized at the earliest practicable date.
 5. Discharge of dredge or fill material or equipment movement
in wetland areas shall be avoided to the maximum extent
practicable.
 6. Discharge of dredge or fill material into breeding areas for
migratory waterfowl must be avoided to the maximum extent
practicable.
 7. To the maximum extent practicable, discharges must not
permanently restrict or impede the passage of normal or
expected high flows or cause the relocation of the water
(unless the primary purpose of the fill is to impound water).
 8. If the discharge creates an impoundment of water, adverse
impacts on the aquatic system caused by the accelerated pass-
age of water and/or the restriction of its flow shall be
minimized the maximum extent practicable.
 9. All temporary fills must be removed in their entirety and the
affected area returned to its pre-existing elevation.

- 202 REMOVE APPROACH: This work shall consist of removing the
P01 existing approach as directed by the engineer. See Basis of
Estimate (Slope flattening and pipe extensions) sheet for location.
- All costs to remove and salvage topsoil, remove and dispose of
approach material, replace the topsoil and seed with class II seed
mixture in accordance with section 708.02 of the Standard
Specifications shall be included in the unit price bid for "Remove
Approach."
- 200 PIPE REMOVAL: All pipe removed on this project will be disposed
P02 of by the contractor. The disposal site will not be visible from
the highway. All costs to remove and dispose of pipe will
be incidental to other items.
- 203 REMOVE & SALVAGE TOPSOIL (Mainline slope flattening): This work
P01 shall consist of salvaging the existing topsoil and placing it back
on the inslope when the borrow placement is complete.
- All costs to complete this work shall be included in the unit
price bid for "Remove & Salvage Topsoil."
- 203 BORROW: The contractor shall locate and provide the borrow
P02 material needed for flattening mainline inslope.
Ordinary compaction shall be used to flatten the inslope.
- Borrow for flattening mainline inslope shall be cross sectioned
at the borrow site and measured by the cubic yard.
Payment for "Borrow" shall be accordance with section 203.02 E3
of the Standard Specifications.

NOTES

203 APPROACH INSLOPE RECONSTRUCTION: The cost of labor, equipment,
P01 and materials to perform the following work will be included in
the price bid for "Approach Inslope Reconstruction."

- 1) Strip and stockpile three inches of topsoil from the embankment and excavation areas.
- 2) Flatten the approach inslopes steeper than 4:1 to 8:1. The material used to flatten the slope will be compacted in accordance with Section 203.02 I of the Standard Specifications. When available the embankment material may be obtained within the R/W in locations approved by the engineer. Embankment not available within the R/W will need to be obtained from borrow. The contractor shall furnish the borrow. The cost to obtain the site and the borrow shall be included in the price bid for "Approach Inslope Reconstruction."
- 3) Replace the topsoil on both the excavation and embankment areas and seed with Class II seed mixture in accordance with Section 708.02 of the Standard Specifications.

Payment will be made for each approach inslope that is flattened. For example, if both inslopes of an approach are flattened, two units will be measured and paid for.

203 FLATTEN DITCH BLOCK SLOPES: The slopes of the ditch blocks shall
P02 be flattened to 10:1. The embankment material required to flatten the slopes will be compacted in accordance with Section 203.02 I of the Standard Specifications. The topsoil shall be stripped from both the embankment and excavation areas, stockpiled, and replaced when the work is complete. Both areas shall be seeded with Class II mix. The excavation may be obtained within the right of way areas approved by the engineer. Only one unit will be measured and paid for per ditch block regardless if one or both slopes were flattened. The cost of excavation, compaction of embankment, stripping, replacing topsoil, and seeding will be incidental to the price bid for "Flatten Ditch Block Slopes" each.

704 TRAFFIC CONTROL: Construction traffic control devices shall be
P01 in accordance with Standard D-704-24, Type U and Type T for flattening approach sideslope. If it becomes necessary to close a lane on mainline, a Type F sign layout as shown on Standard D-704-19 shall be used. All signs shall be removed during non-working hours and the flagging is the responsibility of the contractor. All costs for flagging and traffic control device placement and removal shall be included in the price bid for traffic control.

714 CMP EXTENSIONS: The corrugated metal connecting bands for relay
P01 end sections and extensions of corrugated metal pipe shall be furnished by the contractor. The cost of the bands shall be included in the unit price bid for Corrugated Steel Pipe Culverts.

714 SILTED PIPES: If the contractor encounters silted-In pipes, he
P02 will extend the pipes along the existing flow lines. The silted-In material will be removed 50 feet, unless otherwise directed by the engineer, from the ends of the extended pipe and used to flatten the approach inslopes. Removal of the silt will be incidental to "Approach Inslope Reconstruction."

714 CENTERLINE PIPE EXTENSION: The embankment required to extend the
P03 centerline pipe at sta.13277+42.44 shall be included in the unit price bid for the pipe. The quantity of embankment required for this purpose has been estimated to be 40 CY.

The embankment for other centerline pipe to be extended is included in the price bid for "Borrow".

714 PIPE CULVERTS: If an existing pipe end requires repair before
P04 the extension can be made, the contractor shall remove or straighten the damaged length of pipe to a point where the extension can be made. Regardless of the method used to prepare the existing pipe ends, the pay length will be measured from the point on the existing pipe where the repaired damage or removal begins to the end of the new extension. The pipe lengths as shown on the quantity sheet have been calculated assuming the contractor has removed the damaged ends. The cost of straightening existing pipe ends or removing them shall be included in the price bid for pipe culverts.

754 EXISTING SIGNS: Existing signs will be reset as directed by the
P01 engineer. Cost to reset signs shall be included in the price bid for other items.

APPROACH SLOPE FLATTENING
AND PIPE EXTENSIONS NOTE SHEET

302 BLENDED BASE COURSE: The Blended Base Course shall consist of
P01 a uniform blend of Class 5 Aggregate, the salvaged aggregate base (shldr) and the existing base material. The estimated depth of the blended base is 14". The contractor shall place the Class 5 material on the roadway ahead of the blending operation. The blended base shall be laid in not more than 3" lifts and compacted in accordance with Section 302.04 E of the Standard Specs. Surface tolerance shall be in accordance with Section 302.04 G Type B of the Standard Specs. The unit price bid for "Trimming Base Course" by the SY shall include all costs to obtain the surface tolerance specified.

The Class 5 material will be measured and paid for by the ton of Class 5 material placed on the roadway. All costs for producing, hauling, placing, and compacting the Class 5 material shall be included in the unit price bid for "Aggregate Base Course-Class 5."

The unit price bid for "Blended Base Course" shall include all costs for sizing, blending, stockpiling on inslopes, placing the blended material on the roadway, and compacting the blended base. "

407 RECYCLED HOT BITUMINOUS PAVEMENT - LARGE STONE MIX: The mixture
P01 shall be compacted to at least 92 percent of theoretical maximum density as determined by AASHTO T-209.

407 The virgin gradation for the hot bituminous pavement-large
P02 stone mix shall meet the following gradation and physical requirements:

Sieve Size	Percent Passing
1"	100
3/4"	86-100
1/2"	70-90
No. 4	33-55
No. 8	18-39
No. 30	6-27
No. 200	0-6.0

A minimum of 90% of the plus No. 4 material shall have one fractured face and 70% of the minus No. 4 material shall be produced by a mechanical crushing process. The maximum LA abrasion will be 40%. The maximum allowable shale content will be 5%.

408 HOT BITUMINOUS MIX SUPPLIED: A quantity of 6000 ton of hot
P01 bituminous pavement - class 31 shall be loaded in state maintenance trucks at the plant site. The engineer and the contractor will coordinate so there is the least amount of disruption to the project activities. State maintenance forces will be responsible for all traffic control at their work site. All costs for providing the mix, including the asphalt cement, shall be included in the unit price bid for "hot bituminous mix supplied."

410 MILLED MATERIAL: Any milled material remaining at the completion
P01 of the project shall be stockpiled at the NDDOT stockpile site at reference point 251.04 as directed by the engineer.

704 MAINTAINING ACCESS: The contractor will be responsible for
010 providing access to all residential dwelling and business establishments adjacent to this project. Final details on location of access points and construction procedures shall be worked out with the engineer in the field prior to the start of the project.

704 TRAFFIC CONTROL: The Traffic Control Devices List has been
P01 developed using the following layouts on the Standard Drawings for Traffic Control:

D-704-22, Layout Types K & L for construction trucks hauling material.

D-704-26, Layout Type Y for construction trucks hauling material.

D-704-30, Layout for windrow marking

704 COORDINATION OF DETOURS: The detour required for this project
P02 utilizes ND 9 and ND 20. This detour is also required for project NHU-2-052(014)265 being constructed in Jamestown. Therefore to coordinate all phases of the detour the following conditions apply:

a) Signs and traffic control devices required for the detour have been included in both contracts.

b) The contractor for the project that initially requires the detour shall install the detour signs and devices.

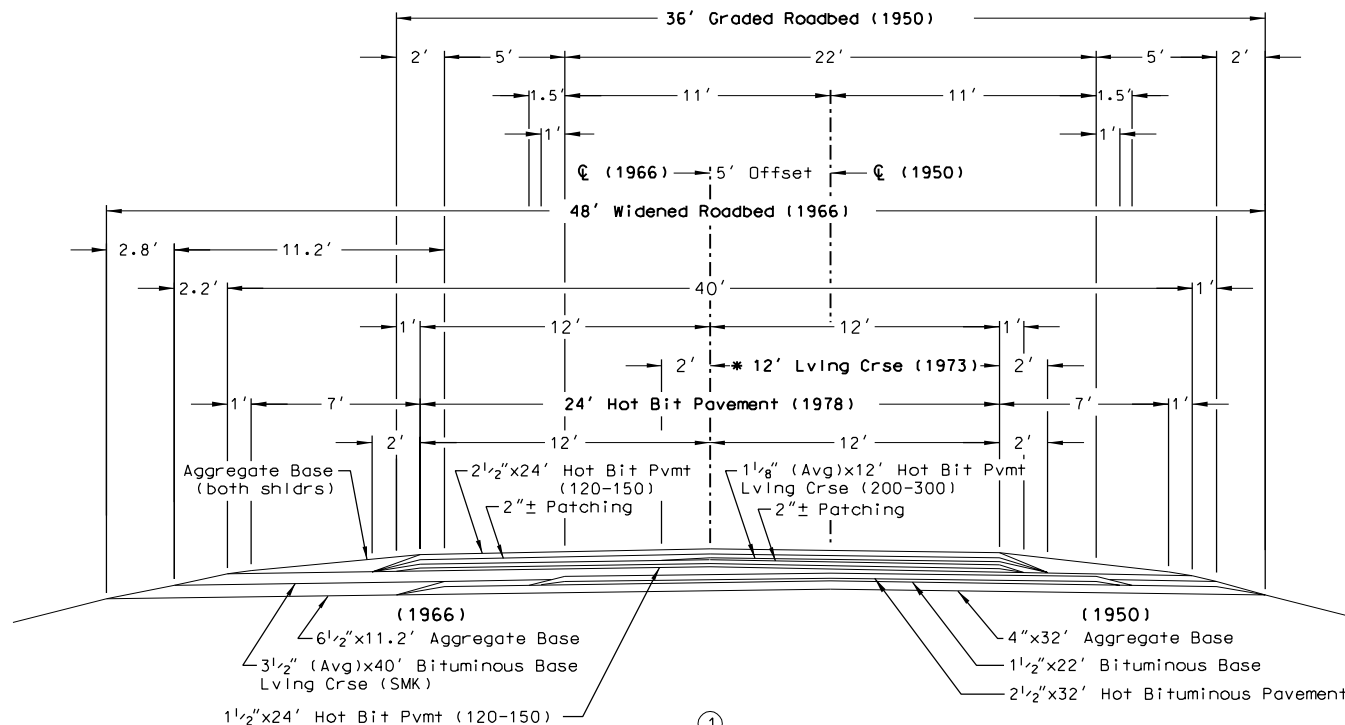
c) That contractor is then responsible for maintaining the detour for the duration of need for all contracts. No extra compensation will be allowed. Any costs associated with an extended maintenance period shall be considered incidental.

d) This contractor will then be responsible for removing the detour traffic control devices and signs and restoring traffic when the detour is no longer needed.

e) All traffic control signs and devices required for the detour will then be deleted from the contract for the remaining project. No payment will be made for any costs associated with the elimination of the items.

f) Contractor should make allowances in their bids for the above conditions

NOTES



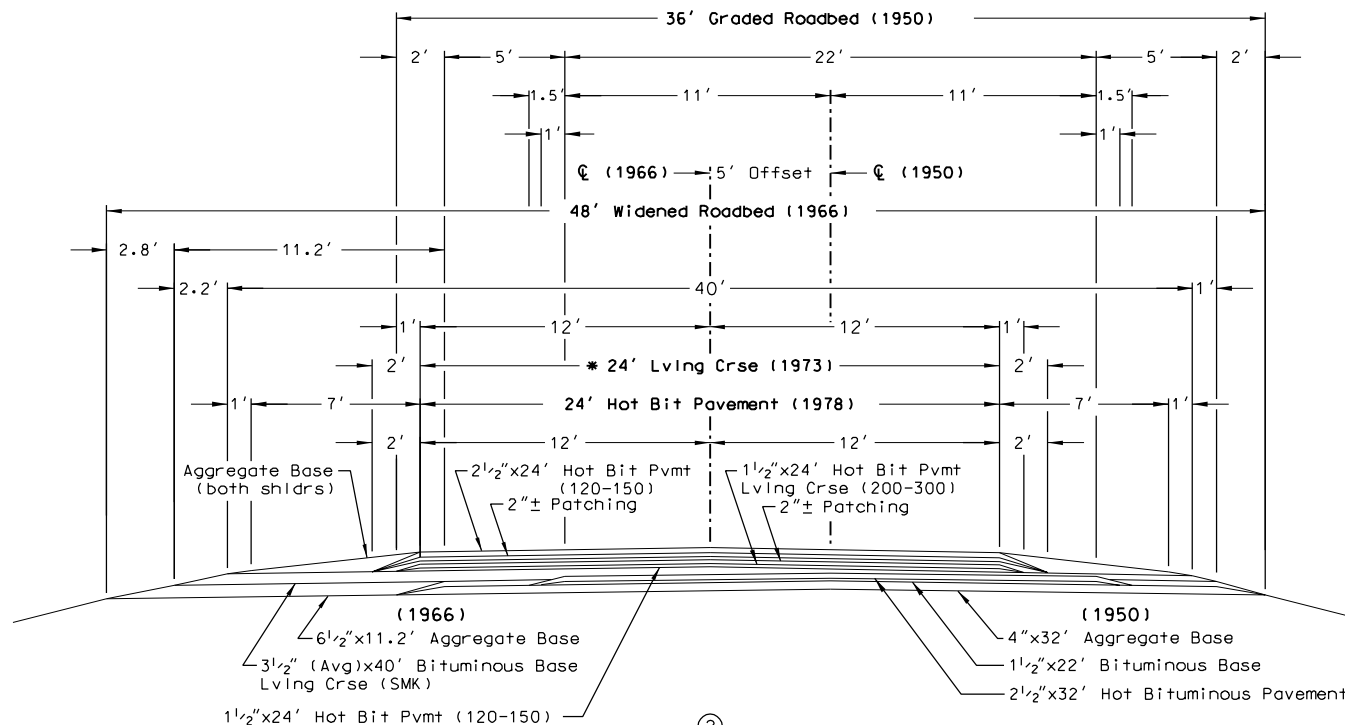
①

*** LEVELING COURSE (1973)**

12928+08.44	to	12963+93.44
12987+93.44	to	13031+93.44
13034+93.44	to	13047+93.44
13050+43.44	to	13107+43.44
13126+93.44	to	13163+93.44
13166+93.44	to	13195+93.44
13197+93.44	to	13204+93.44
13212+93.44	to	13226+93.44
13246+93.44	to	13256+93.44
13288+93.44	to	13336+93.44

EXISTING SECTION

* 12' Leveling Course
(Southbound Lane)



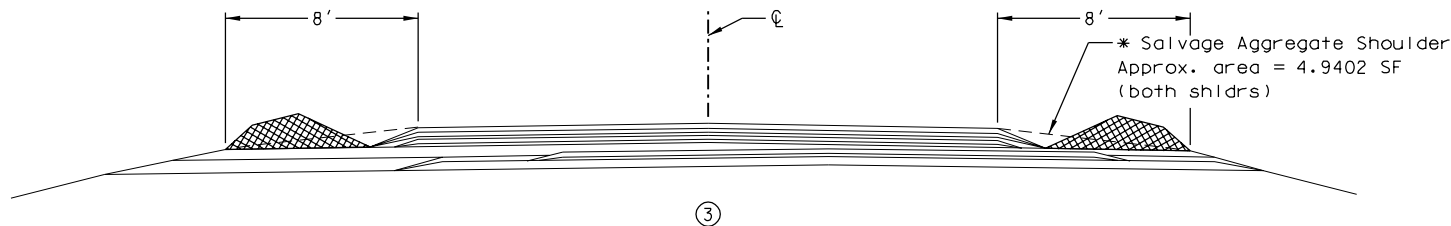
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* LEVELING COURSE (1973)

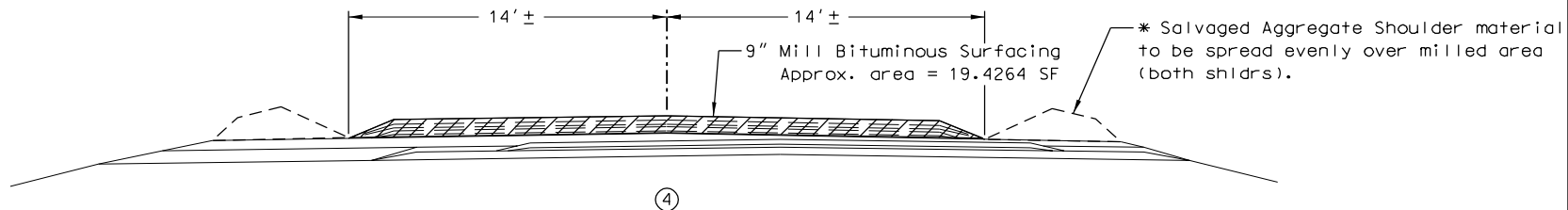
12963+93.44	to	12987+93.44
13031+93.44	to	13034+93.44
13047+93.44	to	13050+43.44
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13195+93.44	to	13197+93.44
13204+93.44	to	13212+93.44

EXISTING SECTION

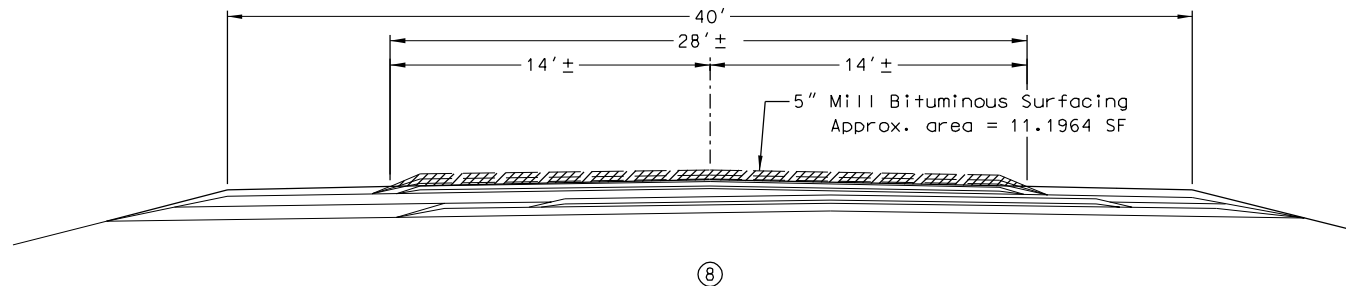
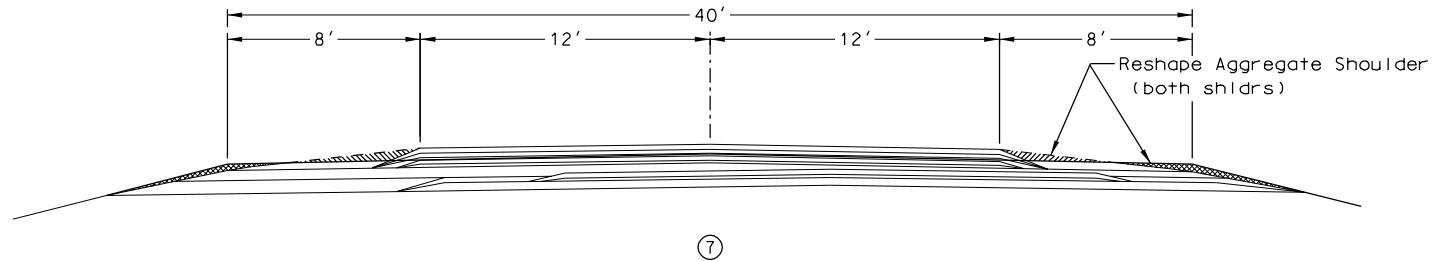
* 24' Leveling Course



* All costs for moving the existing shoulder material off the bituminous slough and spreading the material over the milled area is included in the price bid for "Blended Base Course".

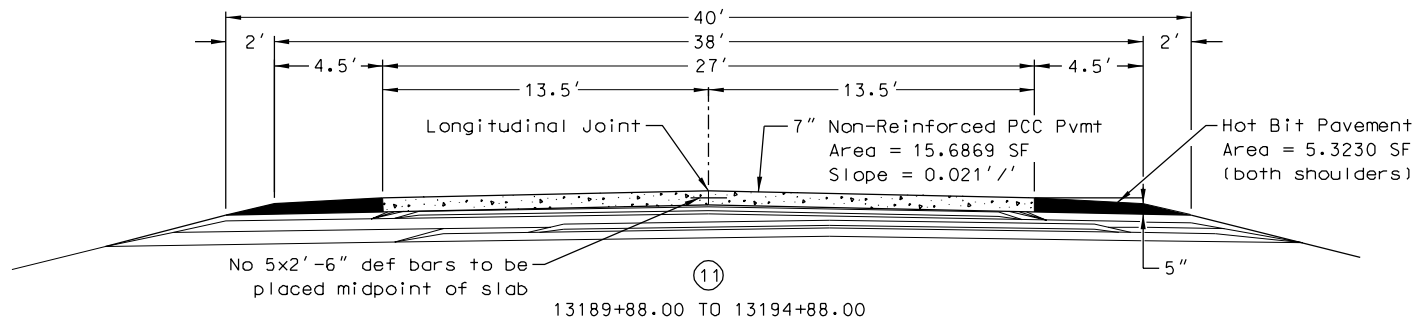
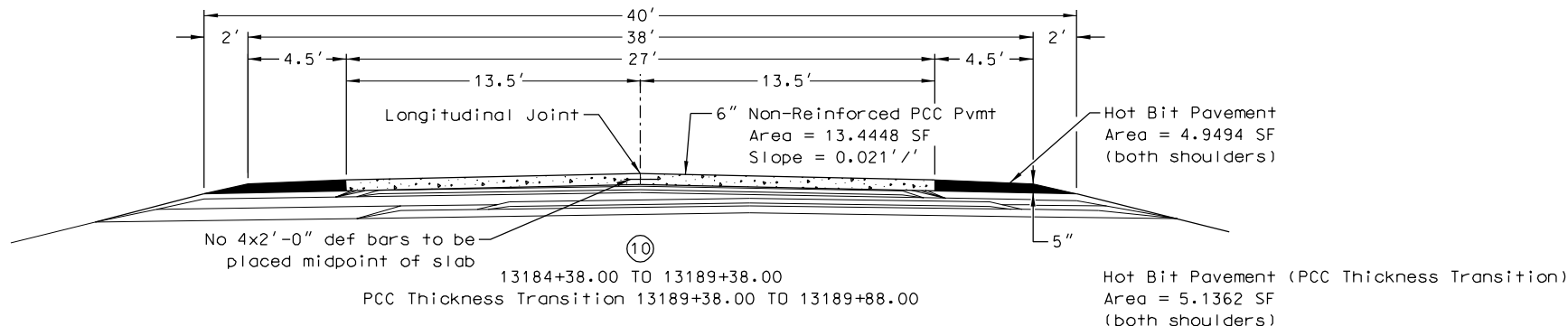
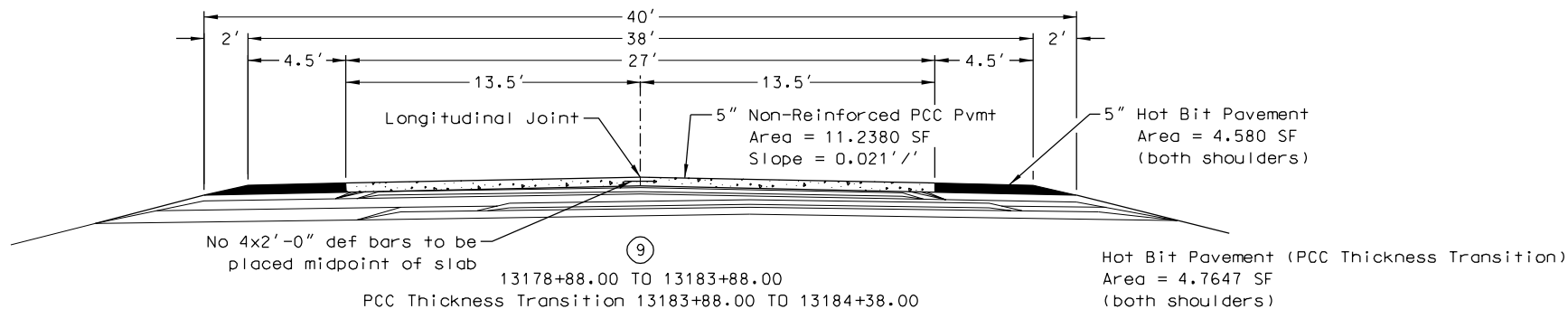


MILLED SECTION
12928+08.44 to 13178+88.00
13194+88.00 to 13336+93.44

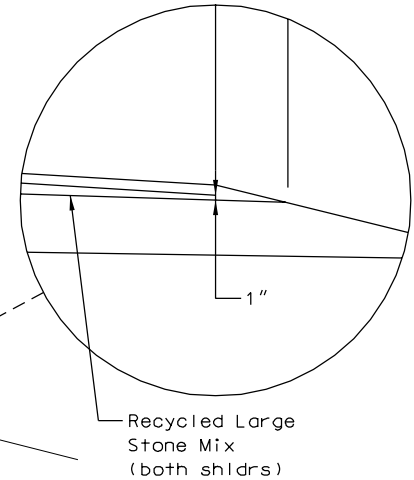
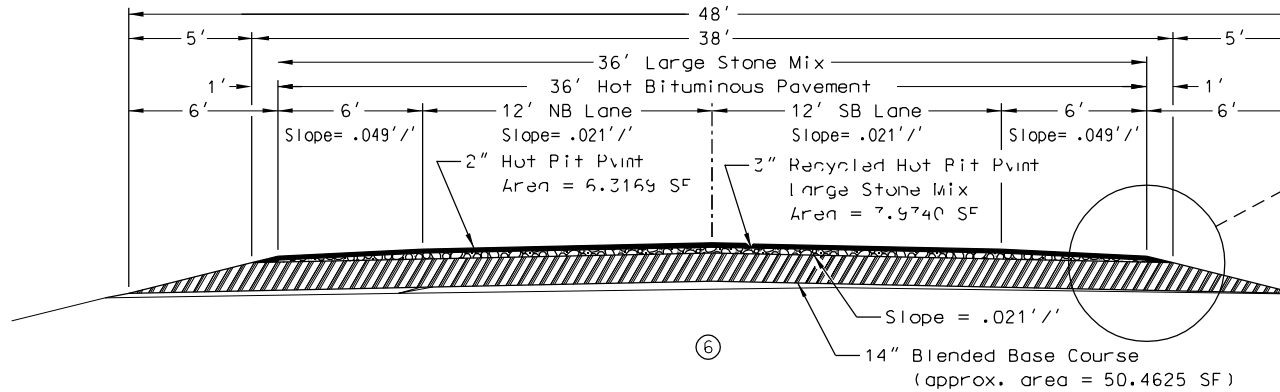
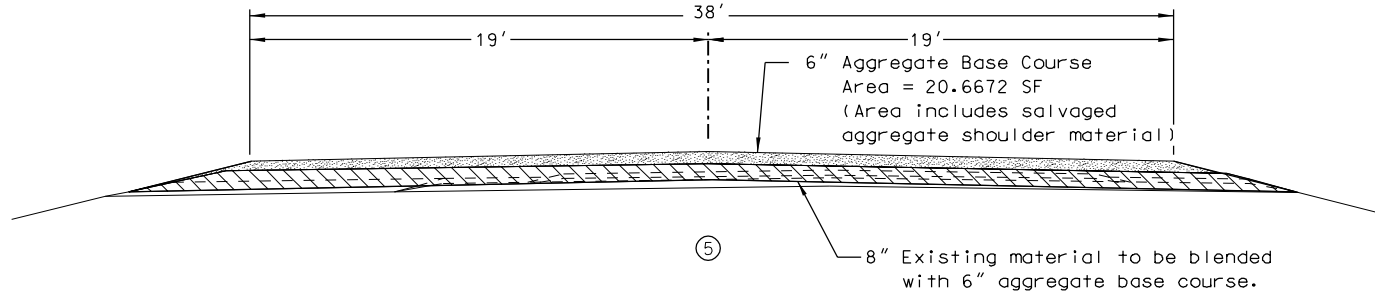


5" MILLED (TEST SECTION)

13178+88.00 TO 13194+88.00

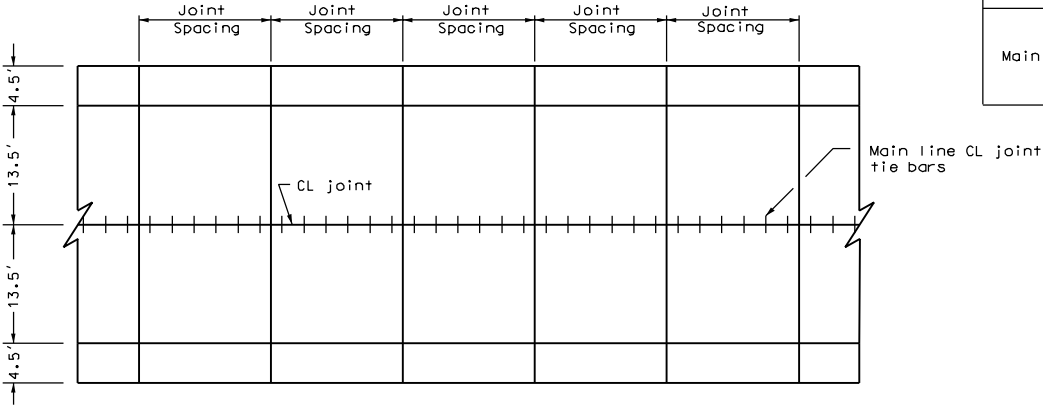


PCC PAVEMENT (TEST SECTION)

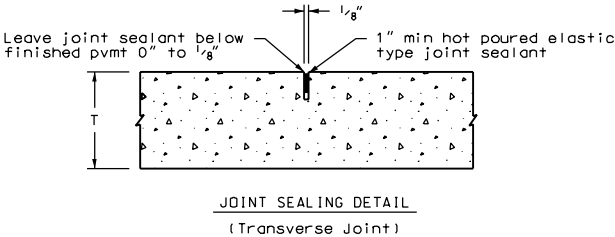
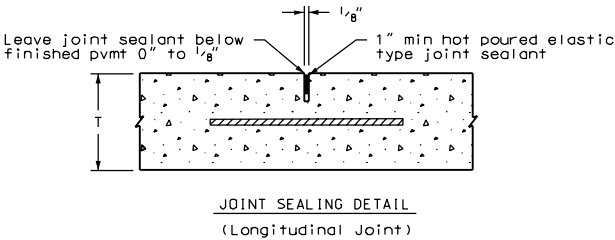
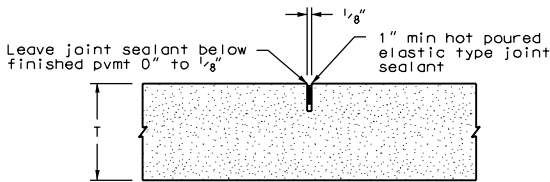
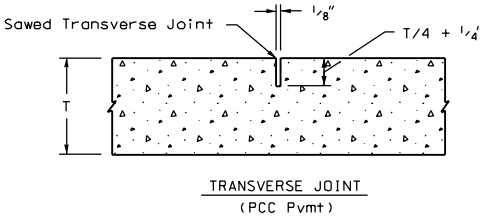
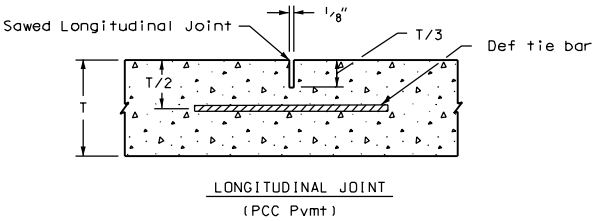
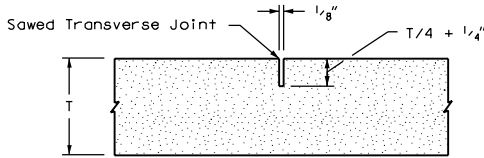


SURFACING SECTION
12928+08.44 to 13178+88.00
13194+88.00 to 13336+93.44

Longitudinal Joint Tie Bars				
Main Line CL	Pavement Depth	Joint Spacing	Bar size	Bar spacing
	5"	12'	#4 x 2'-0"	3'-0"
	6"	13'	#4 x 2'-0"	3'-3"
	7"	14'	#5 x 2'-6"	3'-6"



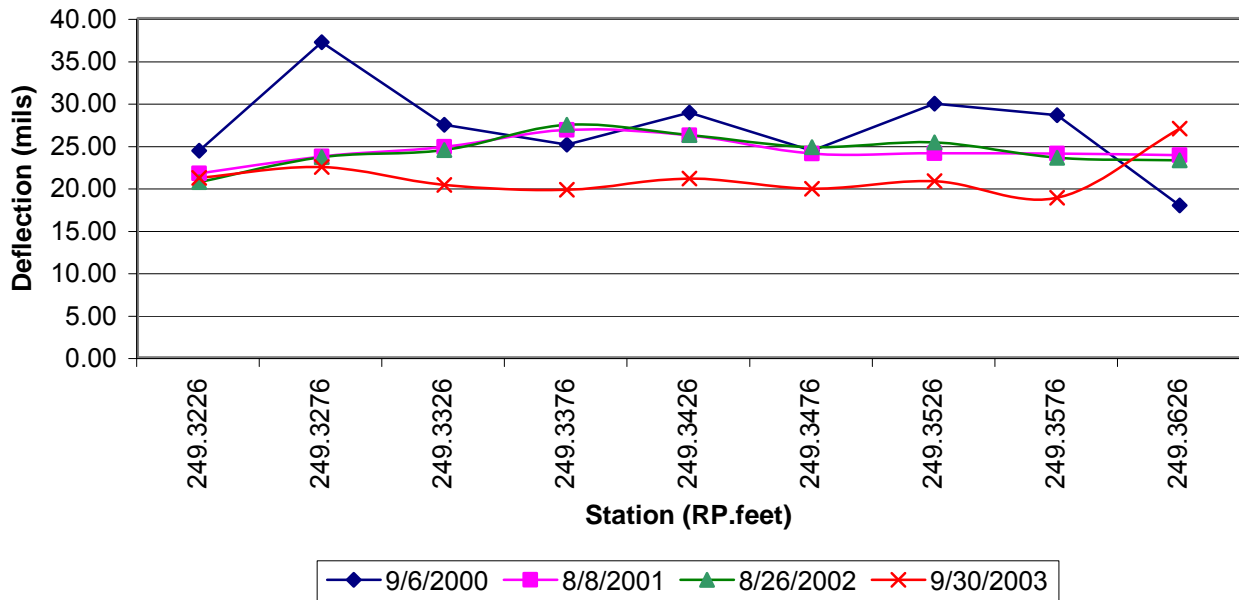
T = Pavement Depth



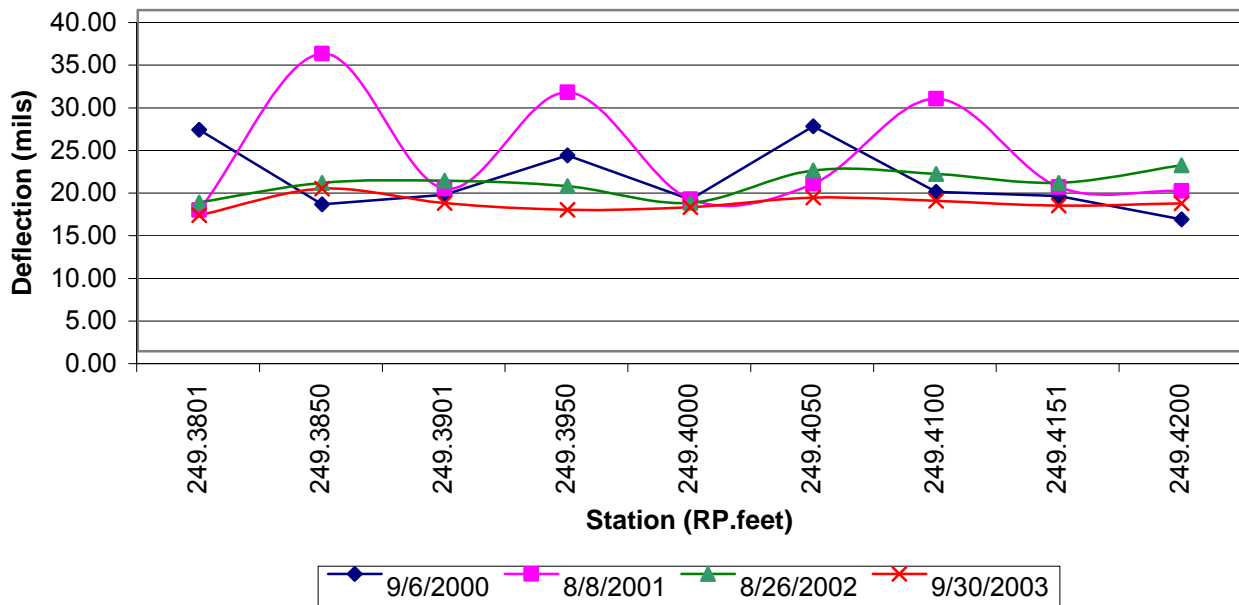
JOINT DETAILS

Appendix B

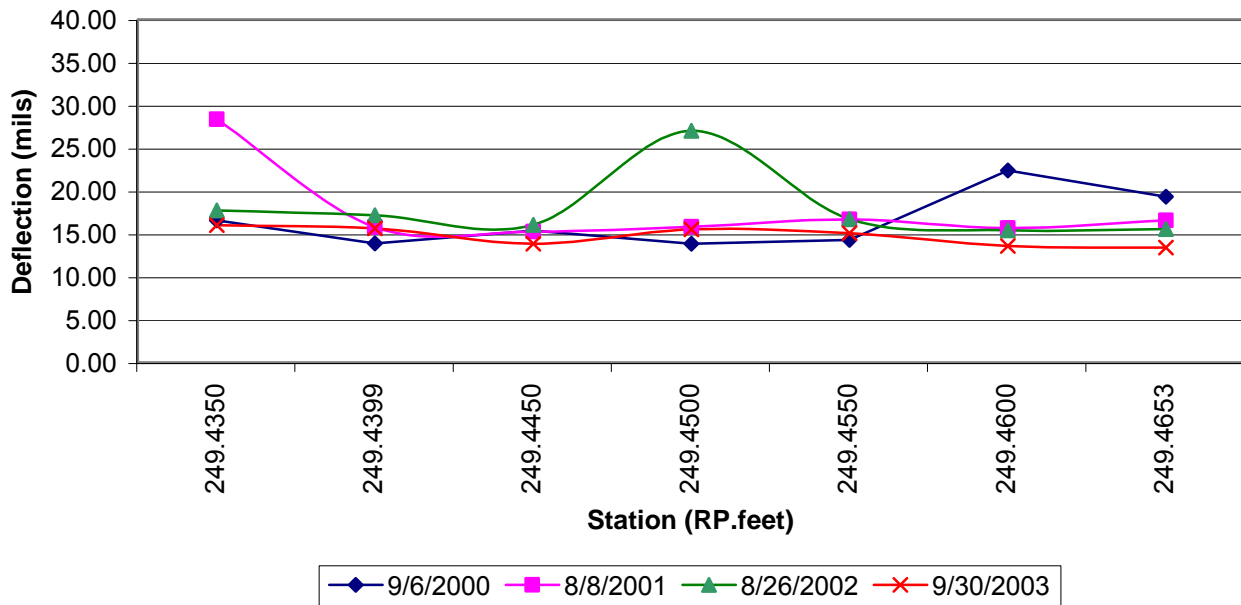
Deflections Section 1



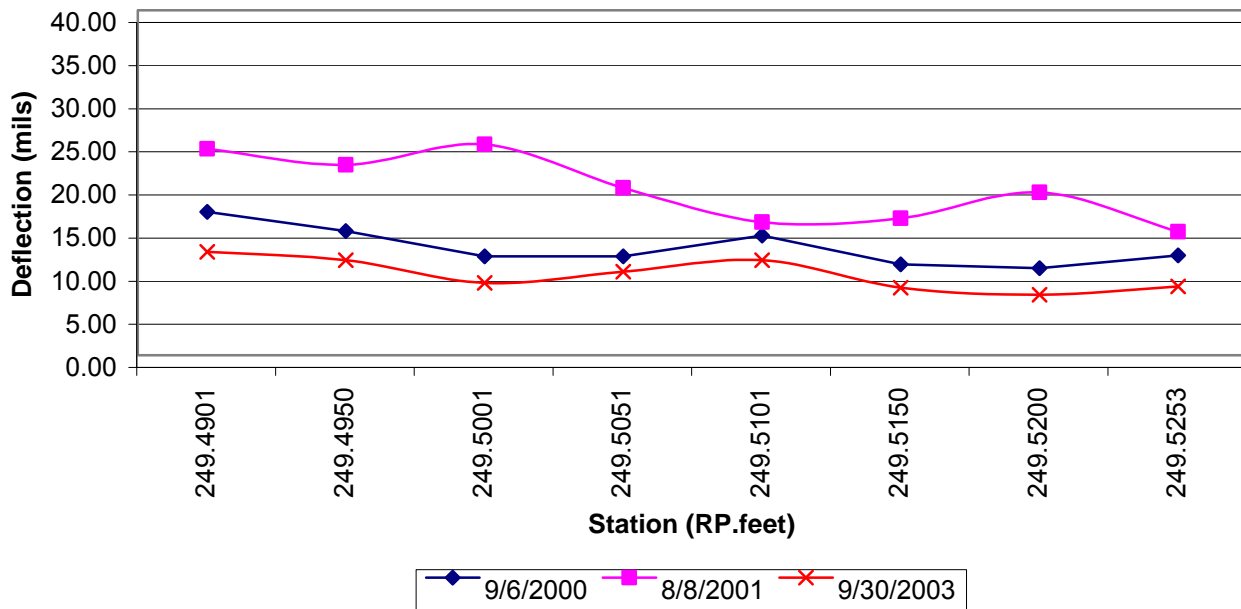
Deflections Section 2



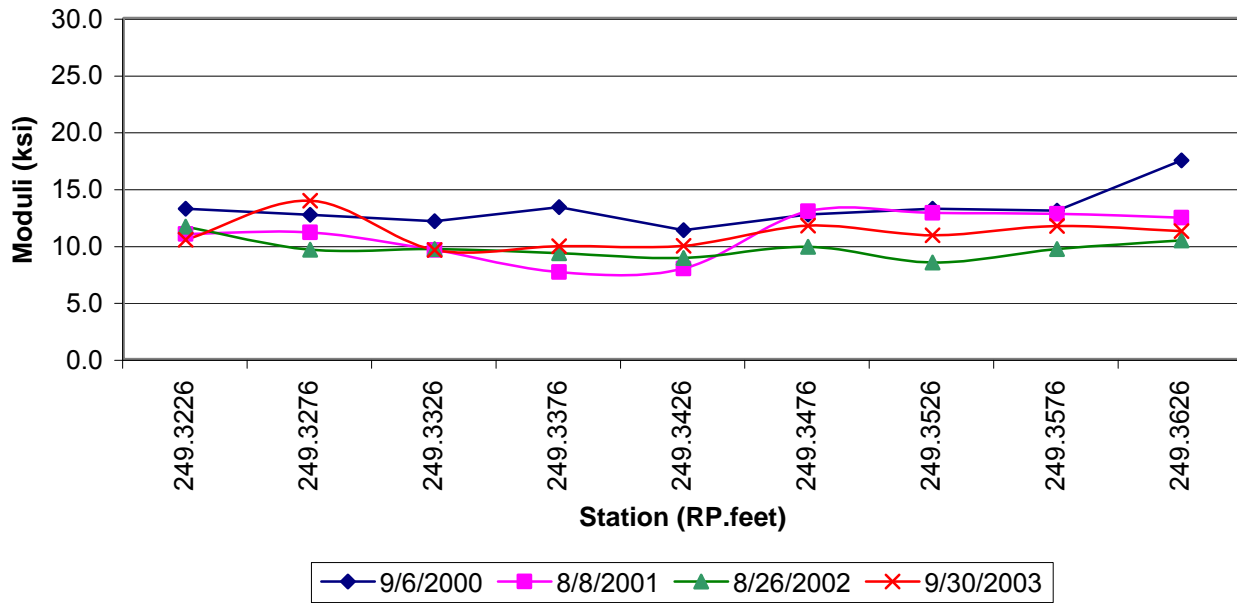
Deflections Section 3



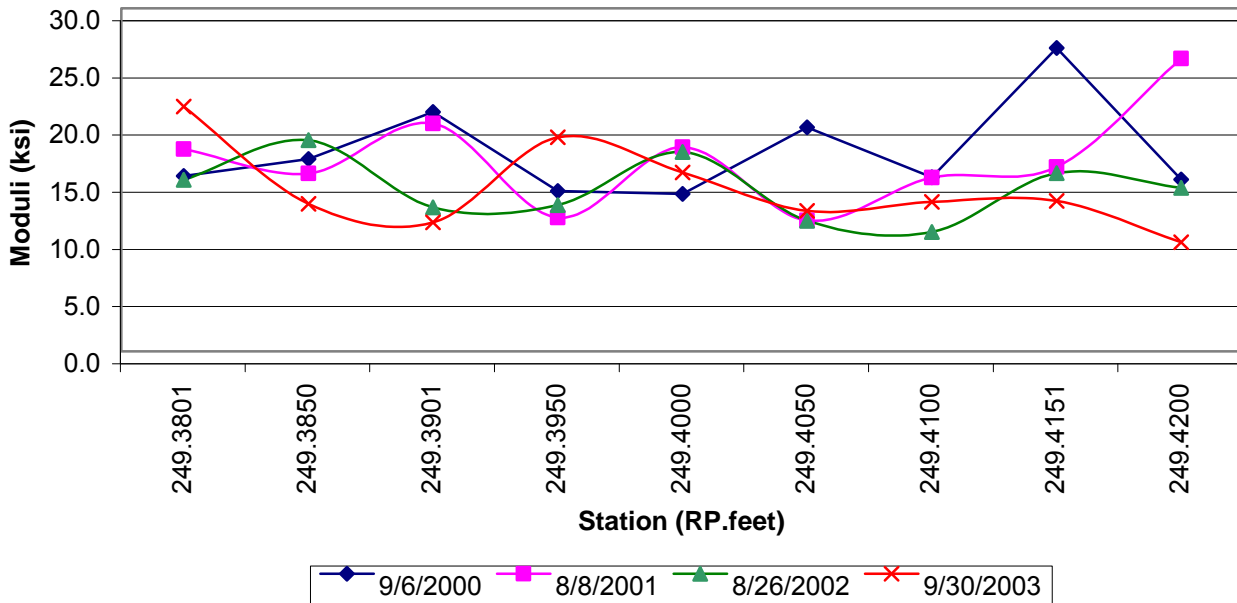
Deflections Control Section



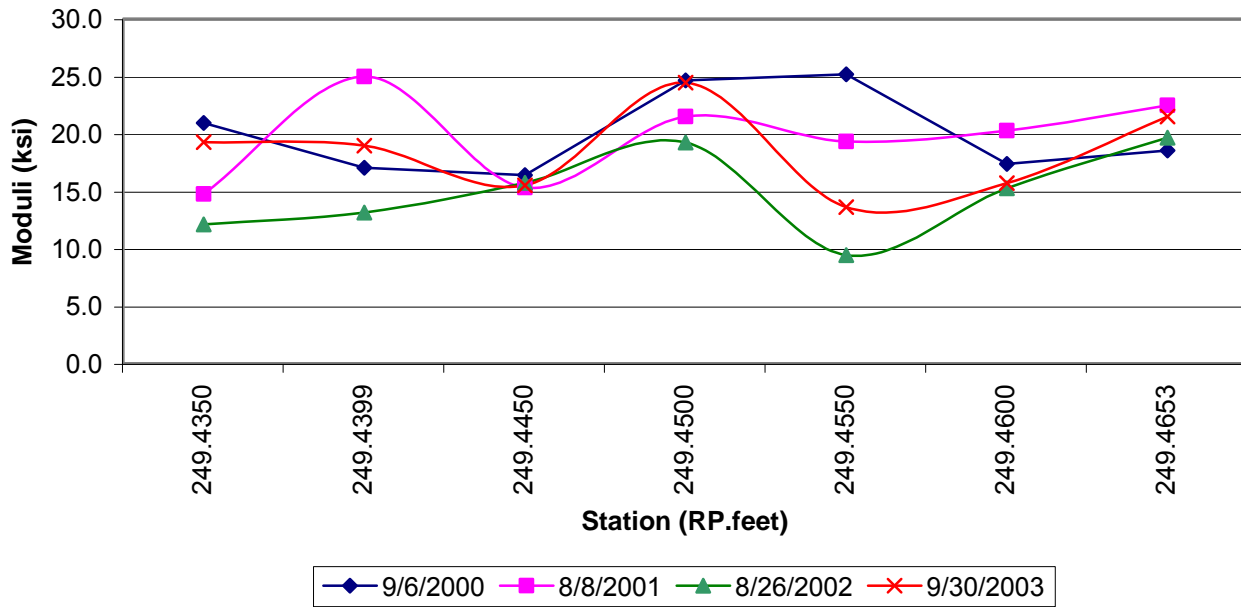
Subgrade Moduli Section 1



Subgrade Moduli Section 2



Subgrade Moduli Section 3



Subgrade Moduli Control Section

